PATENT SPECIFICATION

989,345

DRAWINGS ATTACHED

989,345

Inventors: JOHN CROWE and KENNETH ARTHUR WALLIS

Date of filing Complete Specification: June 28, 1962.

Application Date: July 4, 1961. *No. 24183/61.*

Complete Specification Published: April 14, 1965.

© *Crown Copyright 1965.*

Index at acceptance:—F1 B(2Y1, 2Y3B, 2Y10E, 2Y15, 2Y16A, 2Y16B)

Int. Cl.:—F 02 f

COMPLETE SPECIFICATION

Improvements in or relating to Mufflers or Silencers for the Exhaust Gases of Internal Combustion Engines

We, UPRIGHT SCAFFOLD LIMITED, a company incorporated under the laws of New Zealand, of 146 Gloucester Street, Christchurch, New Zealand, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to mufflers or silencers for the exhaust system for internal combustion engines and has been designed particularly though not solely for use in the exhaust systems of motor vehicles.

At present motor vehicles are produced in a considerable number of makes and models and it seems that each model has a different exhaust system from the others. Consequently manufacturers must make a large variety of replacement silencers or mufflers and also because of this stockists must carry a larger inventory. This of course increases both the manufacturing and marketing costs.

It is therefore an object of the present invention to provide a silencer or muffler for the exhaust systems of internal combustion engines which will reduce the above-mentioned disadvantage or at least provide the public with a useful choic.

Accordingly the invention provides a muffler for the exhaust system of an internal combustion engine comprising, one, or in combination, a plurality of, muffler elements, the or each element comprising, in turn, a barrel having flanges extending radially outwardly therefrom at the ends thereof an end disc positioned at each of the ends of said barrel, each of said end-discs having a flange extending radially outwardly therefrom and being particularly adapted to engage a corresponding one of the flanges at the end of said barrel; inlet and outlet means positioned to abut against each of the ends of said barrel, or each of the outer free ends of a combination of barrels, for providing the exhaust gases of said exhaust system with ingress to and egress from said muffer element, or combination of elements, said inlet and outlet means each comprising, in turn, an end plate having a flange extending radially outwardly therefrom and being particularly adapted in use to engage the flange of a corresponding said end disc, and a conduit extending in an axial direction from said end plate; and connection means connecting the flange of a barrel end, the flange of an end disc and the flange of one of said inlet and outlet means in gas-tight axial engagement with each other, said connection means comprising, in turn, a radially expandable annulus having a groove of such dimensional extent in each of a plurality of directions as to render the aforesaid combination of radially outwardly extending flanges disposable therewithin and generally encompassed thereby.

One preferred form of the invention and modifications thereof will now be described with reference to the accompanying drawing, in which;—

Figure 1 is an exploded, perspective view of the parts forming a silencer or muffler according to the present invention.

Figure 2 is a perspective view of an assembled silencer or muffler according to the invention with a part shown in broken section.

Figure 3 is an exploded perspective view of an alternative construction of a partly assembled silencer or muffler according to the present invention.

Figure 4 is a partly diagrammatic view showing the path of gases through a muffler or silencer using baffle plates as muffling means.

Figure 5 shows one type of baffle plate used.

Figure 6 shows a further type of baffle plate used.

Figure 7 shows a yet further type of baffle plate used.

Figure 8 is a diagrammatic view illustrating a modified silencing element according to the present invention,

Figure 9 is a cross sectional elevation of the element shown in Figure 8,

Figure 10 is an elevation showing a clamping ring engaging an end plate to a silencing element with part shown in broken section,

Figure 11 is an end view of Figure 4 and

Figure 12 shows an alternative method of connecting a pipe to the end plate.

In one preferred form of the invention a muffler 1 for the exhaust gases of an internal combustion engine is formed with one or more silencing elements 2. The silencing element 2 comprises an outer barrel 3 having connection engaging means at each end formed by an outwardly extending annulus 4. A passageway associated with silencing or muffling means for the exhaust gases is provided through the element 2 by a centrally positioned tubular core 5 mounted at either end by extending through apertures in end-discs 6 which are welded or otherwise suitably attached to the barrel. The end-discs 6 have a flange 7 adapted to coact with the annulus 4 and these parts are joined for example, by spot-welding. The core 5 is spot-welded to the end-disc 6 at one end and sleeved through the end-disc 6 at the opposite end without positive attachment thus allowing slight movement to compensate for any differentiation in the expansion of the various parts.

The tubular core 5 has a series of apertures 8 therein formed preferably by partially cutting or stamping out a rectangular section around the sides and folding the cracked out portion inwardly to form louvres 9. The space between the barrel 3 and the core 5 is filled with a fire resistant sound absorbing material for example, a coarse, loosely packed fibre glass 10.

To meet the requirements of the various types of vehicles we have modified the above described element. Thus an element 2a (Figs. 3 and 6) is formed with a barrel section 3 similar to that used in the above described element. The muffling means used in conjunction with the element 2a comprise end baffle plates having a suitably shaped aperture or apertures therein. The baffle plates are attached to each end of the barrel 3.

The baffle plate may be varied in shape and an example of one such baffle 12 is shown in Figures 3 and 7. The baffle plate 12 is formed from a blank of suitable gauge stainless steel with a relatively small central aperture 13 provided therein. Radial slits 14 extend from this aperture 13 to provide adjustable flaps 15. Preferably an even number such as six slits 14 are provided and the flaps 15 formed thereby are arranged to face alternatively inwardly and outwardly. By suitable adjustment of these flaps 15 the passageway through the element 2a may be varied. The baffle 12 has a flange 16 adapted to coact with the annulus 4 on the barrel 3 with the remaining section of the baffle 12 extending inwardly into the barrel 3 when the flange 16 is fitted in position.

A further baffle plate 17 (see Figure 6) is also formed from a blank of metal and is similarly shaped to the baffle plate 12. A flange 18 is provided to abut against the annulus 4 and the remaining portion of the baffle 17 in use extends inwardly slightly into the barrel 3. A plurality of apertures are formed by cracking louvres 19 from the parent metal so that they remain attached along one edge to the baffle plate 17. The apertures are preferably formed in a circle towards the periphery of the baffle plate 17 with the louvres 19 adapted to face inwardly into the barrel 3 in use.

A further modified form of the baffle plate 20 is illustrated in Figure 5 of the accompanying drawing. The baffle 20 is formed from a blank with a flange 21 adapted to coact with the annulus 4. The remaining portion of the baffle 20 is formed as an inwardly coned section having an adjustable aperture adjacent the inner end thereof. The combined length of two of these coned members must be shorter than the barrel to which they are fitted. The adjustable aperture 22 is formed by providing a series of slits 24 adjacent the inner end of the cone with the flaps 23 so made being adjustable to form a suitable aperture to provide the required passageway through the element in use.

Figure 4 illustrates in a partly diagrammatic form how the adjustable baffle plates provide multiple chambers for expanding and cooling the exhaust gases. In this Figure baffle plates 20 are illustrated although it will be realised that the baffle plates 12 or 17 could similarly be used. Also if so desired a combination of these baffle plates could be used in any one muffler. Thus selected types of baffle plates as above described would be attached to each end of the barrel unit and the required number of completed elements combined to form a muffler as will be further described later.

A yet further modified element 2b is illustrated in Figures 8 and 9 of the accompanying drawings. A barrel 3 having annular flanges 4 is formed as was previously described. A longitudinal inner chamber 25 formed by a tubular core 26 is positioned centrally in the barrel 3. The tubular member 26 is mounted at one end by extending through a suitable centrally positioned aperture provided in an end disc 27. This leaves the end 28 protruding past the end disc 27 open to allow the entry of exhaust gases.

An end baffle plate 29 is provided at the opposite end of the barrel 3 and the tubular member 26 is supported at this end by engaging with a centrally positioned cylindrical collar 30 fitted to extend from the inner face of the baffle 29. This closes the opposite end of the tubular member 26 and prevents any direct passage through the elements 2b. An alternative method of supporting the tubular member 26 is to provide a plurality of lugs extending from the end thereof and a complementary plurality of slits in the baffle plate 29. In use the lugs are passed through the slits and folded over to clamp the tubular member 26 in position against the baffle plate 29.

An outer chamber 31 is provided between the tubular member 26 and the barrel 3. Communicating apertures 32 along the length of the member 26 provide a path for the exhaust gases to pass from the inner chamber 25 to the outer chamber 31. The communicating apertures 32 are provided by partially cutting or stamping out a rectangular section about three sides and folding the cracked out portion inwardly to form louvres 33. In use these louvres are directed away from the entrance of gas into the chamber 25.

The baffle 29 has a plurality of apertures communicating with the outer chamber 31 formed therein. These apertures are arranged in a circle by cracking louvres 34 from the parent metal in a similar manner to that described in connection with baffle plate 17. Thus a path is provided through the element 2b for the gases by entering the inner chamber 25 passing through the apertures 32 to the outer chamber 31 and from the outer chamber 31 through the apertures in the baffle plate 29.

All the metal parts used in the above described element are formed from a suitable stainless steel which is stronger and more resistant both to heat and corrosion than is the mild steel at present generally used in constructing known types of mufflers. The seams on the barrel 3 and the core 5 are electrically spot-welded thus excluding any foreign fluxing which may cause corrosion.

It will be realised that the silencing elements 2, 2a and 2b may be manufactured in various sizes and lengths but preferably the barrel 3 is approximately four inches in diameter and is manufactured to form units five inches, nine inches and twelve inches in length.

Inlet and outlet means are provided for each end of an element or elements to complete the muffler and each comprises a circular end member 37 and an outwardly extending pipe 38. The circular end member 37 has further connection engagement means provided as a flange 39 adjacent the periphery thereof which flange 39 is adapted in use to abut against the connection engagement means on one end of a silencing element 2, 2a or 2b.

The pipe 38 may be fitted either centrally or off-centre in the member 37 with a suitable brace provided by for example a gusset 40 welded to both.

In view of the difficulty experienced in welding stainless steel, mild steel pipes are provided extending outwardly from the end members 37. The joint between the outwardly extending pipe 38 and the end member 37 each being of dissimilar metal is adapted to provide a positive interconnection therebetween while still allowing slight relative movement to compensate for the differential in the expansion rate of the two metals used. Thus one joint which will provide a suitable connection between the mild steel and stainless steel is provided by clamping the two parts together. To this end an annular enlargement 41 is jumped up near the end of the pipe 38 to be jointed to the end plate 37. The end 42 is then passed through a suitable aperture in the plate 37 and flared outwardly and pressed in a clamp to complete the joint (see Figures 10 and 11). Thus the end plate 37 is held between the enlargement 41 and the outturned end 42.

A further joint connecting the two dissimilar metals is provided by a weld between a nipple 43 associated with the outwardly extending pipe 38a and the end member 37a (see Figure 12). The end member 37a is a stainless steel member and the outlet pipe 38a is a mild steel member as above described. The nipple 43 is also formed of stainless steel and is inserted in the outlet pipe 38a at the end thereof to be attached to the end member 37a by jumping up both the nipple 43 and the mild steel pipe 38a to form an annular protuberance 44 adjacent the end of the pipe. The nipple 43 may be formed as a cylindrical section from a suitable piece of stainless steel and does not require to be seamed to form a complete tube. Also the nipple 43 is preferably fixed to the outlet pipe 38a by spot welding to prevent relative rotation between the two. The end of the pipe 38a is adjacent the end of the jumped up protuberance 44 and the nipple 43 protrudes outwardly therefrom for a short distance.

An inwardly extending flange 45 surrounds the aperture in the end member 37a. The depth of the flange 45 and the portion of the nipple 43 extending beyond the jumped up protuberance 44 are substantially equal. To form the joint the protruding part of the nipple 43 is passed through the aperture in the end member 37a until the annular protuberance 44 abuts against the outer surface thereof. These members are firmly clamped in this position and positively associated with one another by peening or spot welding the two together. The end of the nipple 43 and the inturned edge of the flame 45 are welded together by for example gas welding. Thus as will be seen a weld is provided and because of the nipple 43 heat resistant stainless steel metal is exposed to the exhaust gases over the weld and on the inner surface of the outlet pipe adjacent thereto. We believe this will assist in reducing corrosion of the outwardly extending mild steel pipe 38a. In this joint the positive connection between the outwardly extending pipe 38a and the end member 37a is provided through the nipple 43 and by the weld 46. The relative rates of expansion between the two metals may be accommodated by the movement between the inturned flange 45 and the welded joint by such expansion tending to deform the end member 37a slightly.

As was above described with the previous type of joint, a gusset or other suitable bracing may also be used to assist in supporting the outwardly extending pipes. This bracing in both cases would be arranged to allow for the relative expansion between the two metals by for example providing a concavity on the end member which would also tend to further deform to accommodate the varying rates of expansion.

Various sizes of outwardly extending pipes 38 or 38a may be provided to meet the needs of most makes of vehicles. The length of the pipes may also be varied if so desired and standard lengths of for example, four and half inch or nine inch pipes may be provided although as will be realised varying other lengths may be custom built if so required. Extra fittings such as for example, bent pipes, flanges, brackets, stone guards, heat deflectors and any other special fittings may of course be attached to the end member 37 or any other suitable part of the completed muffler if so desired.

A connection means is used to connect abutted connection engagement means and comprises a split clamping ring 47 having a substantially centrally positioned groove 48 into which the connection and engagement means may be fitted. A nut 49 and bolt 50 adapted to pass through and coact with collars 51 on either side of the gap so that the ring 47 may be clamped together to decrease the effective diameter thus joining the two connection engagement means.

A suitable sealing and cementing agent for example, a gasket cement is used on all parts fitting into the groove 48. Upon assembly to ensure a proper joint is formed between the connection engagement means being jointed the clamping ring 47 is hammered into position and the nut 49 tightened. This hammering and tightening of the ring 47 is repeated until the flanges 39, 7 and 4 in the muffler represented in Figures 1 and 2 are tightly wedged into the groove 48. It is not generally necessary to fit lock nuts.

While the above described elements provide means for adjusting the degree of noise reduction provided by the muffler it is necessary to dismantle the muffler to adjust the angle at which the louvres in the various baffle members above described are inclined. By modifying the muffler it is possible to effect this adjustment from the exterior of the completed silencer or muffler. This is achieved by for example providing transverse discs in the muffler for example modified baffle plates connected to the end of each element, with each of the discs having a plurality of symmetrically disposed apertures therein. At least one of these discs is connected to an operating arm extending through a suitably positioned slot in the clamping ring connecting the various parts of the muffler together. By loosening the clamping ring and moving the lever in the slot provided the apertures may be moved out of alignment and thus varying the passageway through the muffler which in turn will vary the reduction of noise.

An alternative means of varying the sound issuing from the muffler by adjustment from the exterior thereof, comprises an adjustable flap positioned in the inner surface of the end member to move into the path of the exhaust gases issuing from the inlet conduit. The flap would be adjustable by for example the end of a threaded stud engaged with a nut welded to the inner surface of the end member to vary the position of this flap and thus vary the sound issuing from the muffler in use.

In use where it is desired to assemble a silencer or muffler from the above described parts a suitable length may be made up using one or more silencing elements 2, 2a or 2b or if required a combination of these may be selected. As will be obvious from the foregoing even allowing for the modifications above described a relatively small stock of parts is needed to form a muffler for almost any vehicle. The length required for any given muffler varies both with the type of vehicle to which it is to be fitted and the type of silencing element used.

If the element 2 is used ten to twenty inches of element are required for engines up to fourteen horsepower, fourteen to twenty-four inches of element for engines up to twenty horsepower and eighteen to thirtysix inches for larger engines. The required length of element may be built from the modular sections kept in stock for example three elements may be connected as shown in Figure 2 of the accompanying drawings. The elements are connected together by clamping rings 47 as was above described.

The tone of the silencer or muffler may be adjusted by varying the angle of the louvres 9 facing into the tube 5. In use the louvres 9 are directed into the flow of gas passing through the tube 5 and if a quieter engine is required the louvres are bent down towards a position substantially at right angles to the main surface of the tube. This adjustment may be readily achieved by for example using a screw driver before the elements are assembled. It is not necessary to have the louvres 9 all inclined uniformly and if so desired the louvres may be turned down in oppositely disposed sections of the core to cause added turbulence in the exhaust gases passing therethrough.

The element 2a formed with either the baffle plates 12, 17 or 20 may be connected in a similar manner to that described with reference to elements 2 above. A plurality of expansion chambers is thus provided and a partly diagrammatic representation of the path through such a muffler is represented in Figure 4. Adjustment of the tone of the muffler may also be readily achieved with the use of this element. The flaps 15 or 23 may be adjusted to enlarge the passageway through the element 2a as was above described or the louvres 19 may be opened inwardly thus exposing a larger aperture through the baffle 17.

The element 2b is arranged as was above described so that the inlet gases pass in through the inner chamber 25 and the tone of element 26 may be adjusted by varying the angle of the louvres 33 and 34. Because there is no direct passageway through element 2b a shorter length of this type of element may be used to achieve the required silencing.

When the correct length of silencing element of any of the above described types has been selected and assembled suitable inlet and outlet means are attached to each end to complete the muffler. The end members with the correct pipe sizes are selected. If necessary an end member with a pipe offset as shown for example in Figures 1 and 2 may be used. Because the end member may be attached to the end of the element at any point these offset pipes may be swivelled to any position in a full circle allowing a maximum number of fitting positions to be covered with a minimum possible number of parts. The standard muffler is then complete. It may have further attachments fitted if so required such as, flanges, brackets, stone-guards and heat deflectors as was above-mentioned. Also the muffler may be fitted with the adjustable tone means operable from the exterior if this is required.

Because of the range of independent parts above described a large variety of mufflers may be formed using relatively few basic parts. A skilled mechanic is thus able to solve any silencing or fitting problem for a car, truck, launch or even a motor mower by a suitable assembly. Also because of the adjustability in the silencing means the problem of the performance against the silencing of a motor may be resolved to the particular motorists own requirement. The three different types of elements provided and the provision for adjusting interchanging and combining them provides a maximum versatility in silencing effects attainable.

Stainless steel is fifty percent stronger than mild steel and is resistant to both heat and corrosion. Because of this the mufflers are more resistant to wear and generally have a longer life than would mild steel muffler. However sometimes damage is caused to the muffler by rocks or other flying objects and it is possible to replace the damaged section without having to replace the whole muffler.

WHAT WE CLAIM IS:—

1. A muffler for the exhaust system of an internal combustion engine comprising, one, or in combination, a plurality of, muffler elements, the or each element comprising, in turn, a barrel having flanges extending radially outwardly therefrom at the ends thereof, an end disc positioned at each of the ends of said barrel, each of said end-discs having a flange extending radially outwardly therefrom and being particularly adapted to engage a corresponding one of the flanges at the end of said barrel; inlet and outlet means positioned to abut against each of the ends of said barrel, or each of the outer free ends of a combination of barrels, for providing the exhaust gases of said exhaust system with ingress to and egress from said muffler elements, or combination of elements, said inlet and outlet means each comprising, in turn, an end plate having a flange extending radially outwardly therefrom and being particularly adapted in use to engage the flange of a corresponding said end disc, and a conduit extending in an axial direction from said end plate; and connection means connecting the flange of a barrel end, the flange of an end disc and the flange of one of said inlet and outlet means in gas-tight axial engagement with each other, said connection means comprising, in turn, a radially expandable annulus having a groove of such dimensional extent in each of a plurality of directions as to render the aforesaid combination of radially outwardly extending flanges disposable therewithin and generally encompassed thereby.

2. A muffler as claimed in Claim 1 including a plurality of muffler elements with said connection means for connecting one of said plurality of muffler elements with one of said inlet and outlet means at one of the ends thereof, connecting another of said plurality of muffler elements with the other of said inlet and outlet means at one of the ends thereof, and connecting the remaining ends of the remainder of said plurality of muffler elements with each other.

3. A muffler as defined in Claim 1 or Claim 2 wherein said end-discs comprise a baffle plate having a generally centrally disposed aperture, and slits extending radially outwardly therefrom, said slits defining adjustable flaps therebetween, enabling the size of a passageway through said muffler element to be varied.

4. A muffler as defined in Claim 3 wherein the number of slits is an even number, and the flaps are turned alternately in each of a plurality of directions from the plane of said baffle plate.

5. A muffler as defined in Claim 1 or Claim 2 wherein said end-discs comprise a baffle

plate having a plurality of apertures extending therethrough and disposed in spaced relationship generally annularly about the periphery thereof, said apertures being defined by turning louvres away from the plane of said baffle plate.

6. A muffle as defined in Claim 1 or Claim 2 wherein said end-discs comprise a baffle plate having a generally cone-shaped configuration, an aperture positioned substantially adjacent the apex thereof and extending therethrough, and slits extending from said aperture, said slits defining adjustable flaps therebetween enabling the dimensional extent of said aperture to be varied.

7. A muffler as defined in Claim 1 or Claim 2 wherein the end-disc positioned at one end of said muffler element comprises a first baffle plate having a generally centrally disposed aperture, and slits extending radially outwardly therefrom, said slits defining adjustable flaps therebetween enabling the size of a passageway through said muffler element to be varied, and the end-disc positioned at the other end of said muffler element comprises an other baffle plate having a plurality of apertures extending therethrough and disposed in spaced relationship generally annularly about the periphery thereof, said apertures being defined by turning louvres away from the plane of said other baffle plate.

8. A muffler as defined in Claim 7 wherein the number of said slits is an even number, and said flaps are turned alternatively in each of a plurality of directions from the plane of said baffle plate.

9. A muffler as defined in any one of the preceding claims wherein each of said baffle plates is shaped and positioned to extend inwardly of said barrel enabling said plates being oppositely disposed with respect to one another to define a chamber therebetween when a plurality of muffler elements are axially aligned.

10. A muffler as defined in any of the preceding claims wherein some of the component parts and elements defined therein are fabricated of stainless steel.

11. A muffler as defined in Claim 1 or Claim 2 wherein each of said end-discs has an aperture extending therethrough, a tube positioned within said barrel and being spaced annularly therefrom, said tube extending through the aperture in each of said discs and being fixed with respect to one and movably disposed with respect to an other enabling said barrel and said tube to differentially move with respect to one an other as a result of differential expansion therebetween, said tube having apertures extending therethrough and spaced longitudinally thereof and annularly thereabout, said apertures being defined by turning louvres from the tube inwardly and in such a direction longitudinally thereof as to direct exhaust gases passing through said tube into said apertures; and a fire resistant sound absorbing material positioned within said barrel and about said tube.

12. A muffler as defined in Claim 10 wherein one of said end-discs has an aperture extending therethrough; a collar positioned upon an other of said end-discs and extending therefrom, a tube positioned within said barrel and spaced annularly therefrom, said tube extending through the aperture in said one end-disc and extending to and being positioned within said collar, said tube having apertures extending therethrough and spaced longitudinally thereof and annularly thereabout, said apertures being defined by turning louvres from the tube inwardly and in such a direction longitudinally thereof as to extend away from the direction of travel of exhaust gases passing therethrough, and a plurality of apertures extending through the other of said end-discs and spaced annularly thereabout, said apertures being positioned radially outwardly of said collar enabling exhaust gases entering said tube at the end thereof extending through the aperture in said one end-disc to pass therethrough, into said barrel annularly about said tube and outwardly of said barrel through the apertures extending through the other of said end-discs.

13. A muffler as defined in Claim 1 wherein the end plate of said inlet and outlet means is fabricated of a dissimilar material than that from which said conduit is fabricated with a joint between said end plate and said conduit, said joint comprising a nipple fabricated of the same material as said end plate, said nipple being disposed within said conduit and extending to and within an aperture extending, in turn, through said end plate, each of said conduit and said nipple having an annular protuberance extending radially outwardly therefrom with the protuberance of the nipple being positioned within the protuberance of said conduit, said protuberance being positioned in abutting relationship with respect to said end plate.

14. A muffler for the exhaust system of an internal combustion engine when constructed, arranged and operable substantially as herein described with reference to the accompanying drawings.

UPRIGHT SCAFFOLD LIMITED.
Per: Boult, Wade & Tennant,
111/112 Hatton Garden, London, E.C.1.
Chartered Patent Agents.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press (Leamington) Ltd.—1965. Published by The Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.

Fig.1.

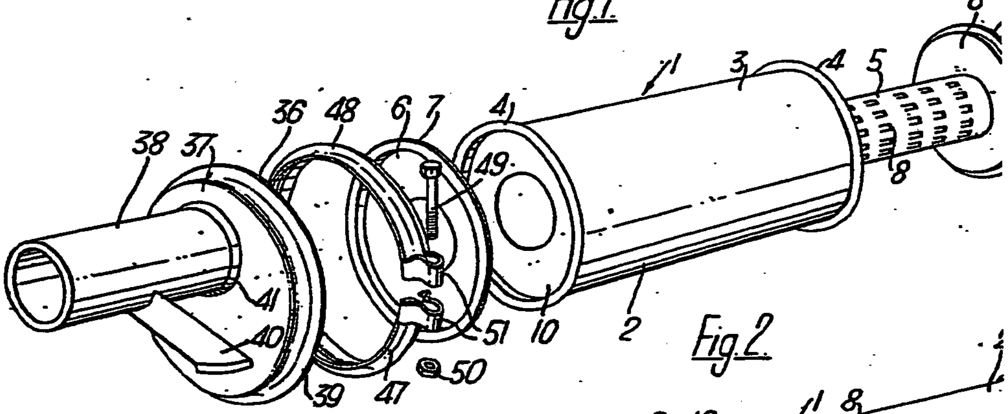
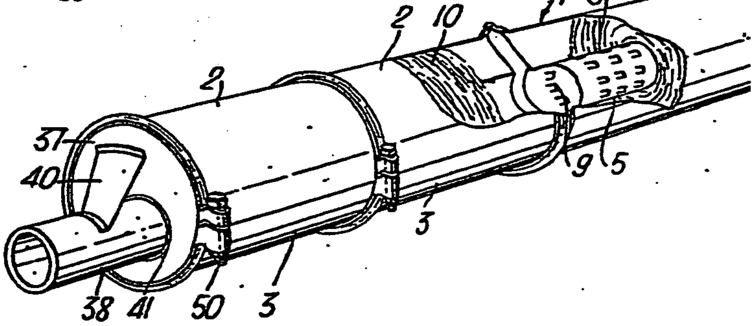


Fig.2.

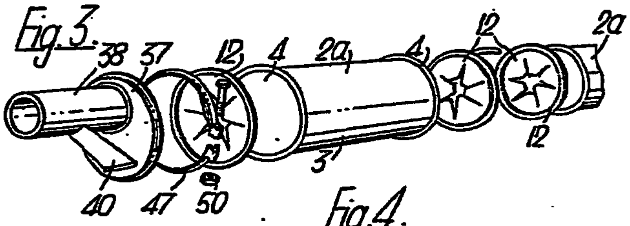


989345 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

Fig.3.



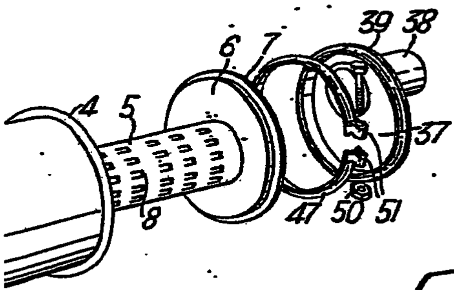
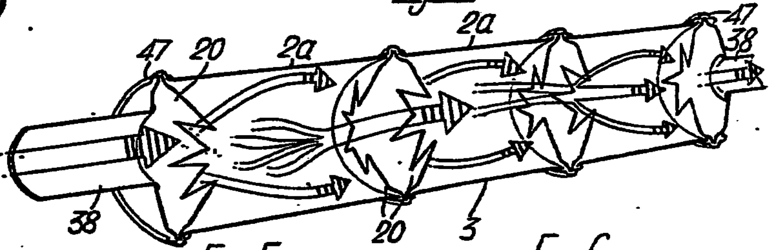


Fig.4.



2

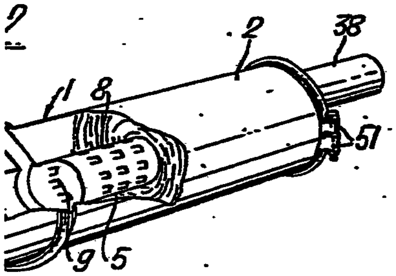


Fig.5.

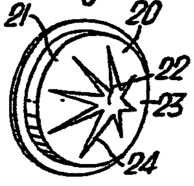


Fig.6.

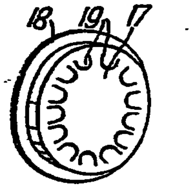


Fig.8.

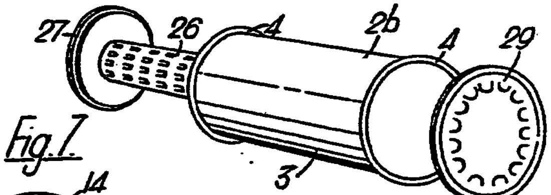
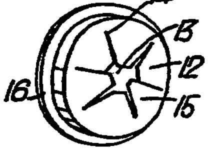


Fig.7.



989345 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

Fig.1.

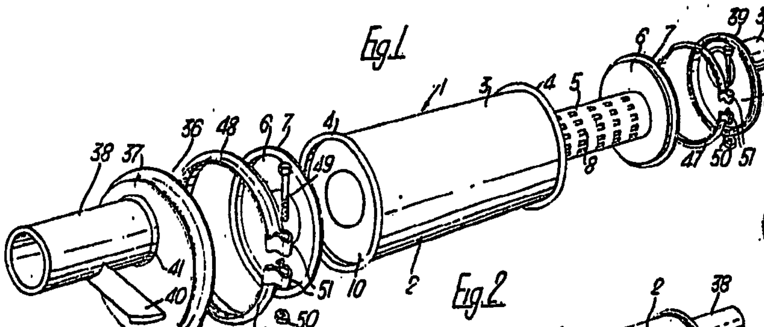


Fig.2.

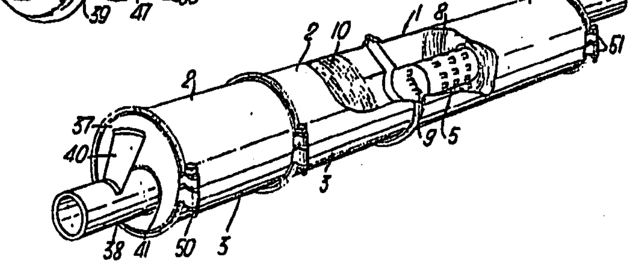


Fig.3.

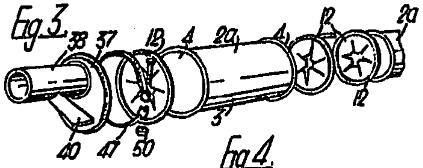


Fig.4.

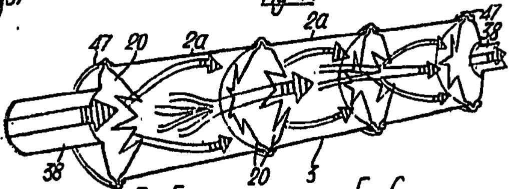


Fig.5.

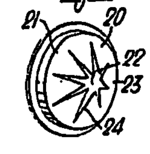


Fig.6.

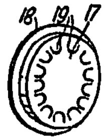


Fig.8.

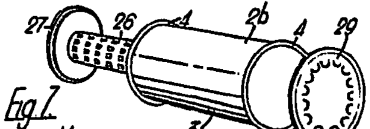
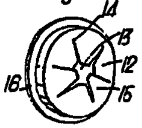


Fig.7.



989345 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

Fig. 9.

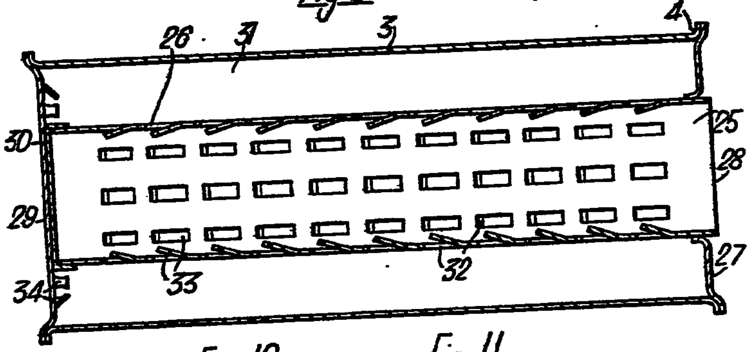


Fig. 10.

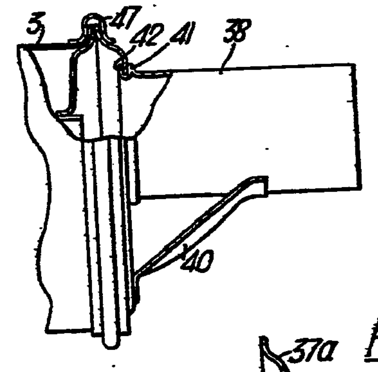


Fig. 11.

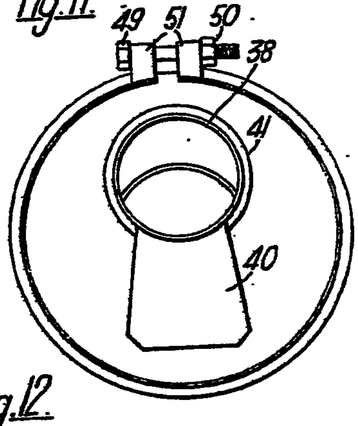


Fig. 12.